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DAMPING CHARACTERISTICS OF THREE UNTREATED STEEL PLATES.(U)
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U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

DAMPING CHARACTERISTICS OF THREE UNTREATED STEEL PLATES

by

Howard N. Phelps, Jr.

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17 February 1964

17 p.

INTRODUCTION

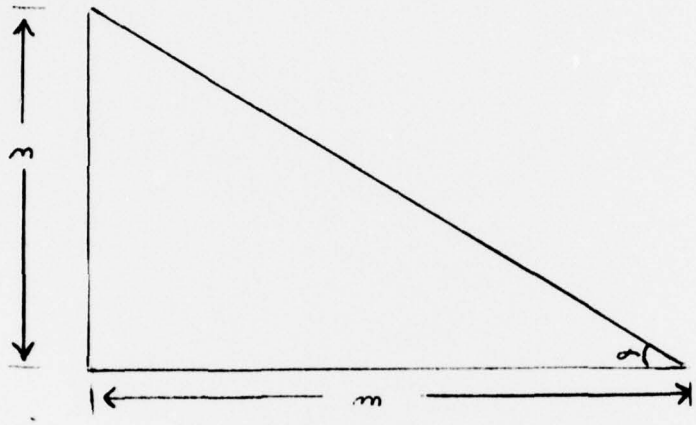
This memorandum presents the damping characteristics of three untreated steel plates that will be used as references for damping evaluations to be made on treated panels of the same size. These plates are: 30" x 30" x 1/8" carbon steel, 30" x 30" x 60 milcarbon steel, and 30" x 30" x 1/4" HY-80 steel.

EXPERIMENTAL PROCEDURE

The calibration of the instrumentation is discussed in detail in reference (a). A block diagram of the calibration instrumentation set-up is shown in Figure 1. The method of calculation which was used for the calibration is discussed in reference (b). The results of the calibration are given in Figures 3 and 4. This calibration shows the measuring limits of the instrumentation.

The method used for the damping studies of the panels consists of measuring the decay of a free vibration within a 1/3 octave frequency band. This method is discussed in detail in references (c) and (h). Figure 2 is a block diagram of the instrumentation used.

The plate to be tested is suspended using nylon cord, as recommended by reference (d). A drop of light oil is placed between the accelerometer and the plate, and the accelerometer is tightened with a torque of 20 inch-pounds, as recommended by reference (i). The instrumentation is allowed to warm up for at least one-half hour (reference (a)). The plate is then excited by impact. The decay of the vibration of the panel in a pre-set 1/3 octave frequency band is recorded on the storage oscilloscope. This was repeated at 1/3 octave band center frequencies starting at 100 cps and ending at 16,000 cps. Using a direct decay readout scale, tangent α can be read directly.



From reference (c), $\tan \alpha = \frac{n}{m}$

And the decay rate (db/sec) is

$$D = \frac{na}{mt} = \frac{a}{t} \tan \alpha$$

where: a= the vertical scope deflection calibration constant (db/cm)

t= the sweep rate of the scope (sec/cm)

n= ordinate (cm)

m= abscissa (cm)

From reference (e), the percentage of critical damping is

$$\% \, \%_c = 1.84 \frac{D}{f}$$

where: D= the decay rate (db/sec)

f= the 1/3 octave band center frequency (cps)

From reference (f), the loss factor (η) is

$$\eta = \left(\frac{1}{\pi}\right)\left(\% \, \%_c\right)$$

where $\% \, \%_c$ = the percentage of critical damping

DISCUSSION OF RESULTS

It was found that good repeatability of results was not possible. Reference (g) states that "measurements of transient phenomenon in

vibrating systems are inherently subject to some variability." Therefore, as suggested by reference (g), five decay curves were averaged for each 1/3 octave band center frequency. Therefore, the results presented in this memorandum are an average of five decay rates.

The decay rates of the 30" x 30" x 1/8", 30" x 30" x 60 mil and the 30" x 30" x 1/4", steel plates are presented in Figures 5, 6, and 7, respectively. The percentage of critical damping and the loss factors of the 30" x 30" x 1/8", 30" x 30" x 60 mil and the 30" x 30" x 1/4"steel plates are presented in figures 8, 9, and 10, respectively. Figures 11 and 12 provide a comparison of the three untreated steel plates.

SUMMARY

Three untreated steel plates tested are to be used as references for future evaluations of treated panels of the same dimensions. The instrumentation being used at present is satisfactory for such tests. Figures 3 and 4 show the measuring limits of the instruments. Figure 5 through 12 show the damping properties of the three untreated steel plates.

Howard N. Phelps, Jr.

HOWARD N. PHELPS, JR.
Mechanical Engineer

LIST OF REFERENCES

(a) H. N. Phelps, Jr. and M. F. Borg, "Calibration of Instrumentation for Vibration and Damping Tests", USL Technical Memorandum No. 933-236-63, 22 August 1963.

(b) H. N. Phelps, Jr., "Two Methods of Determining Damping of Free, Damped Systems", USL Technical Memorandum No. 933-329-63, 4 Dec 1963.

(c) LTJG J. E. Barger, USN, "An Experimental Determination of the Degree of Damping of Structures," USL Technical Memorandum No. 1210-94-59, 17 June 1959.

(d) J. L. Ciringione, "Study of Methods for Evaluating the Damping Properties of Materials," Progress Report 3 on Lab Project 6254, Material Laboratory, New York Naval Shipyard, 21 July 1961.

(e) Geiger and Hamme (Consultants in Acoustics), "The Concept of Damping of Structureborne Sound and Vibration for Noise Control," Contract NObs-73549, NS-713-212 (SF013-11-01, Task 1353), Report No. USN-1, April 1961, Astia No. AD290487.

(f) L. Peterson and J. L. Ciringione, "Study of Methods for Evaluating the Damping Properties of Materials," Progress Report 2 of Lab Project 6254, Material Laboratory, New York Naval Shipyard, 15 June 1961.

(g) Bolt, Beranek and Newman Inc., "Damping of Flexural Vibrations in Plates by Free and Constrained Visco-Elastic Layers," Report No. 632, Final Report on Phases I - III of Contract NObs-72452(375), Ser 375-168, NS713-212, 28 May 1959.

(h) R. F. DelSanto, Jr., "Compendium of Information on Surface Damping Applications", USL Technical Memorandum No. 1466-3-60, 23 Mar 1960.

(i) R. D. Pennington, "Accelerometer Mounting," Technical Data No. 522, Endevco Corporation, August 1962.

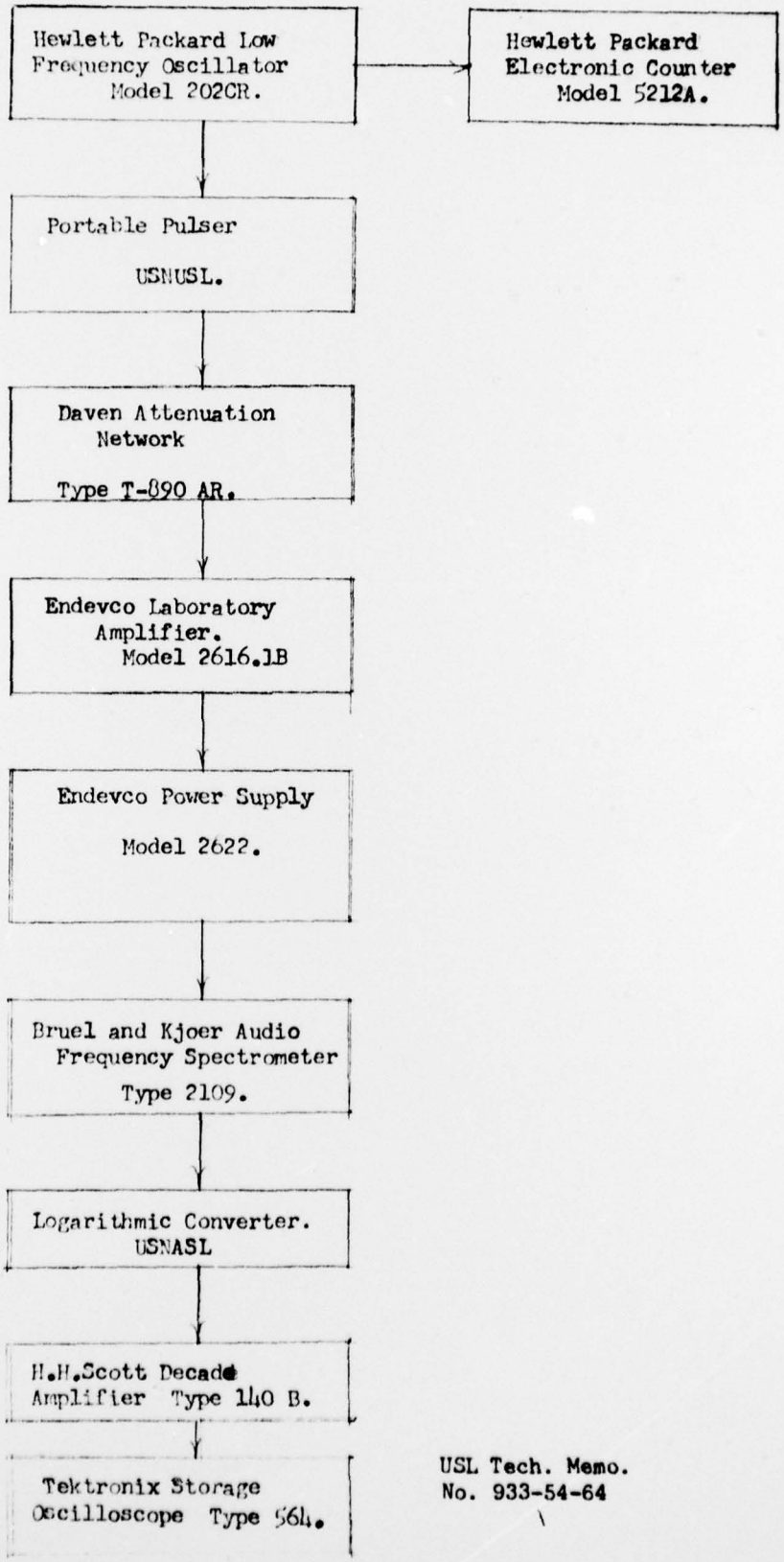


Figure 1.

BLOCK DIAGRAM FOR CALIBRATION OF INSTRUMENTATION.

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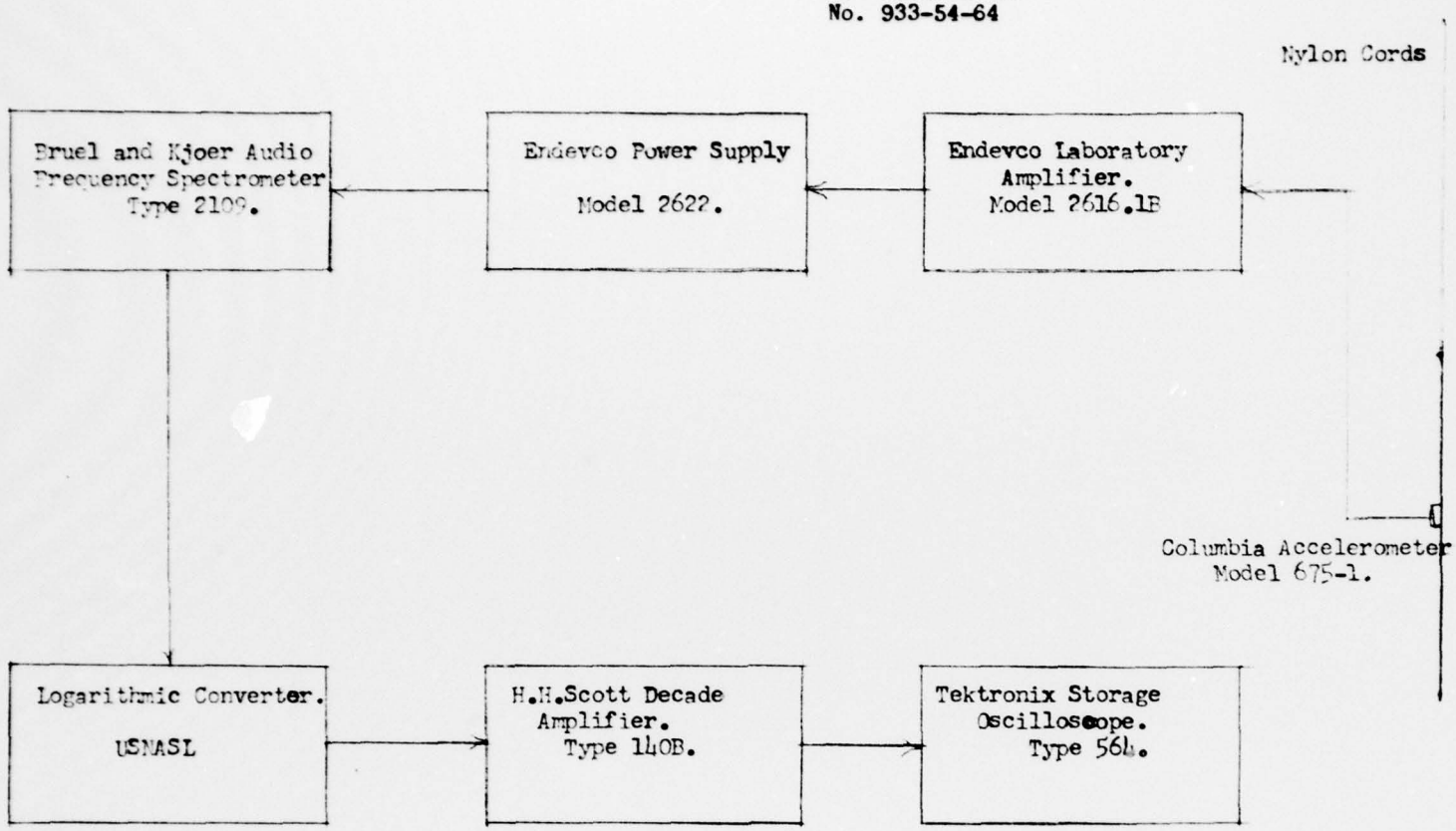

Figure 2.

INSTRUMENTATION FOR DAMPING STUDIES OF FLAT PLATES.

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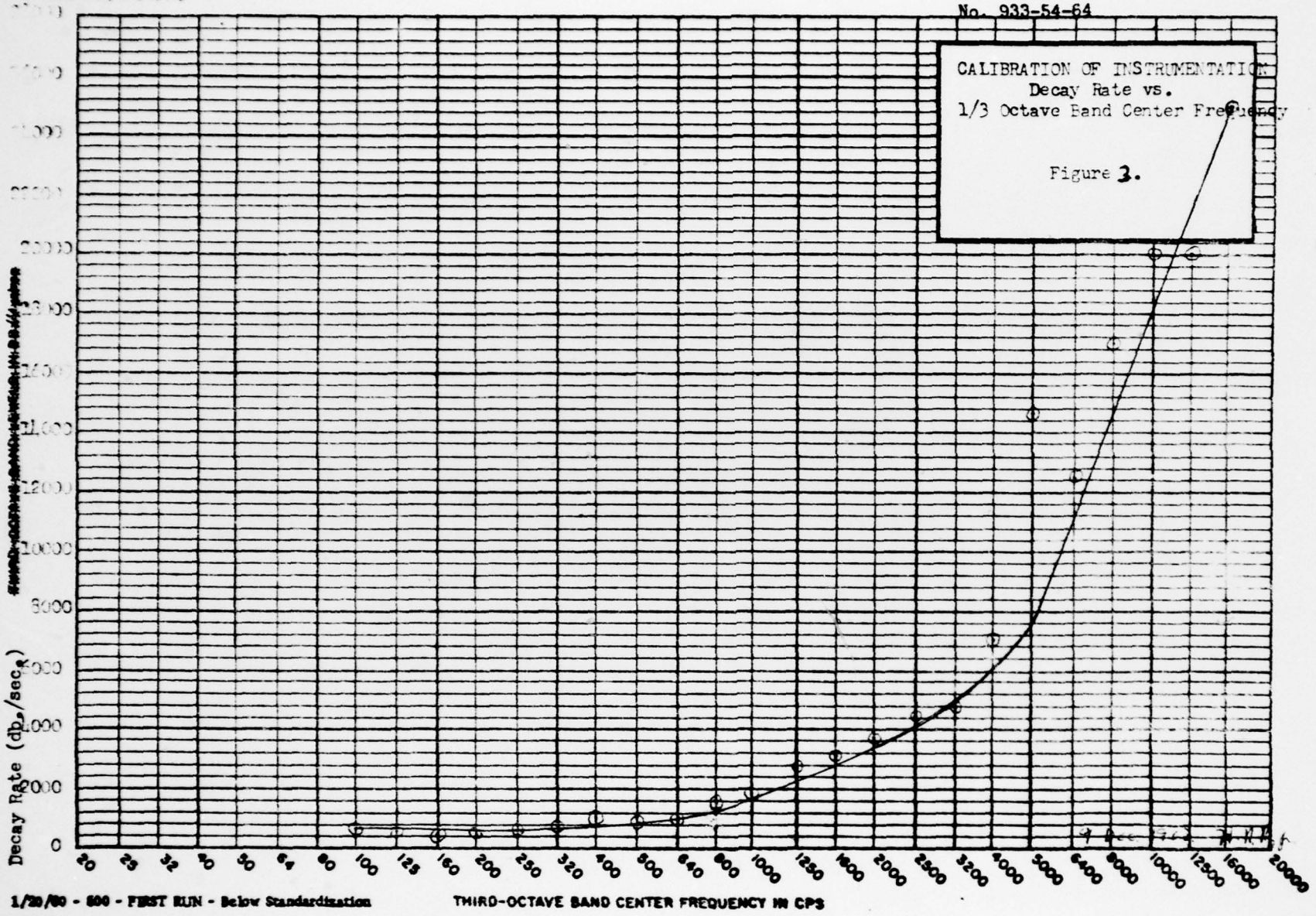

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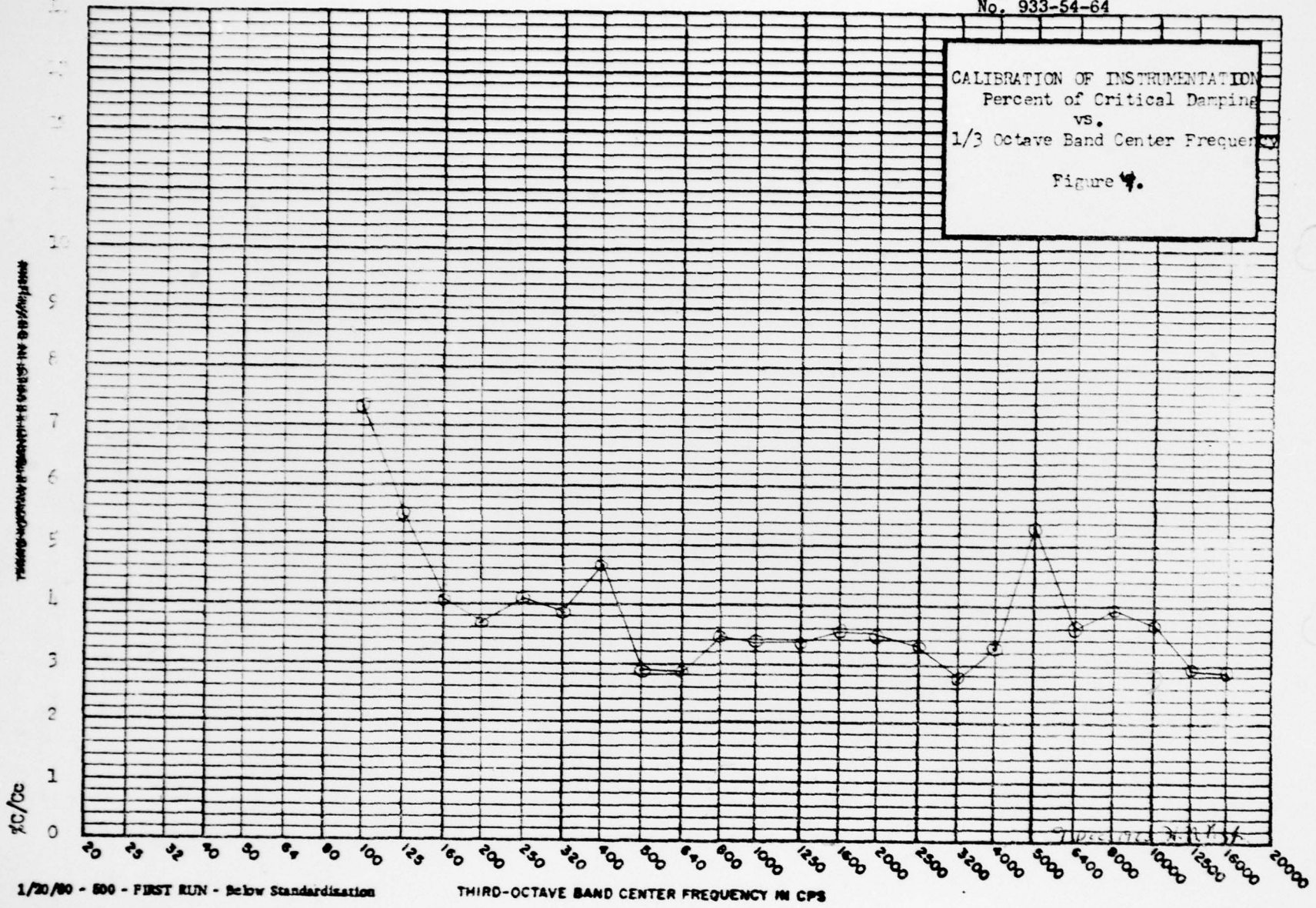

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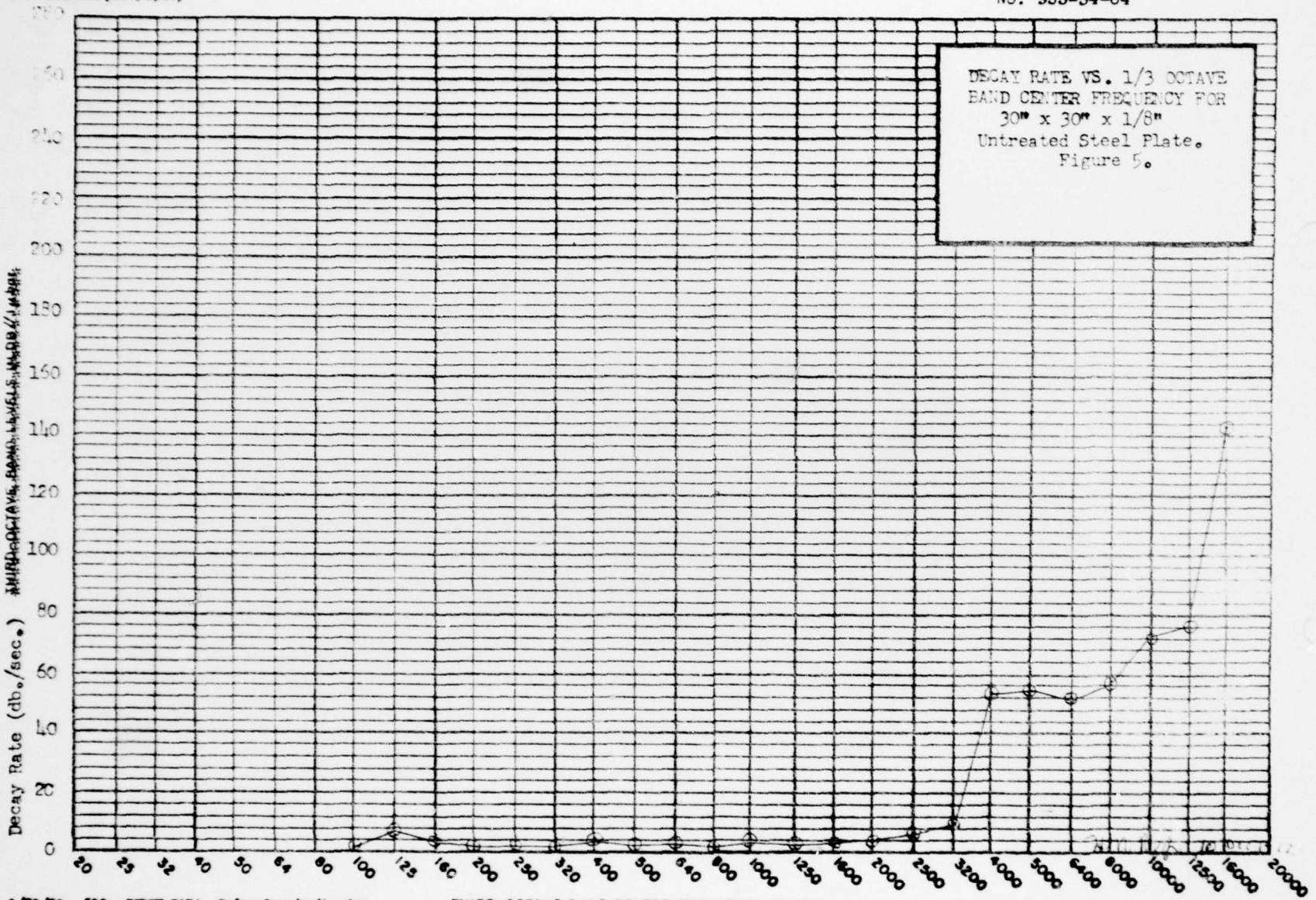

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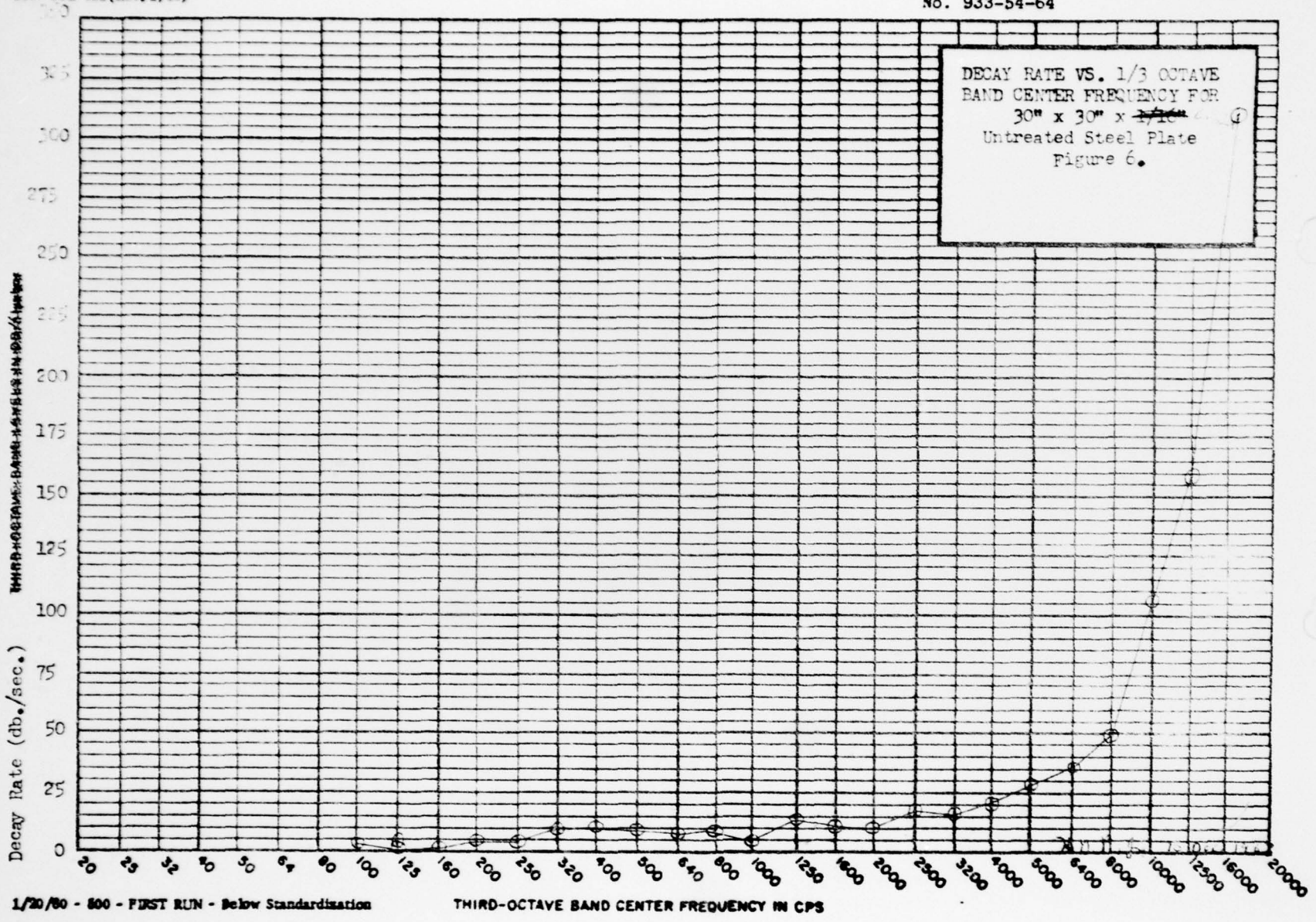

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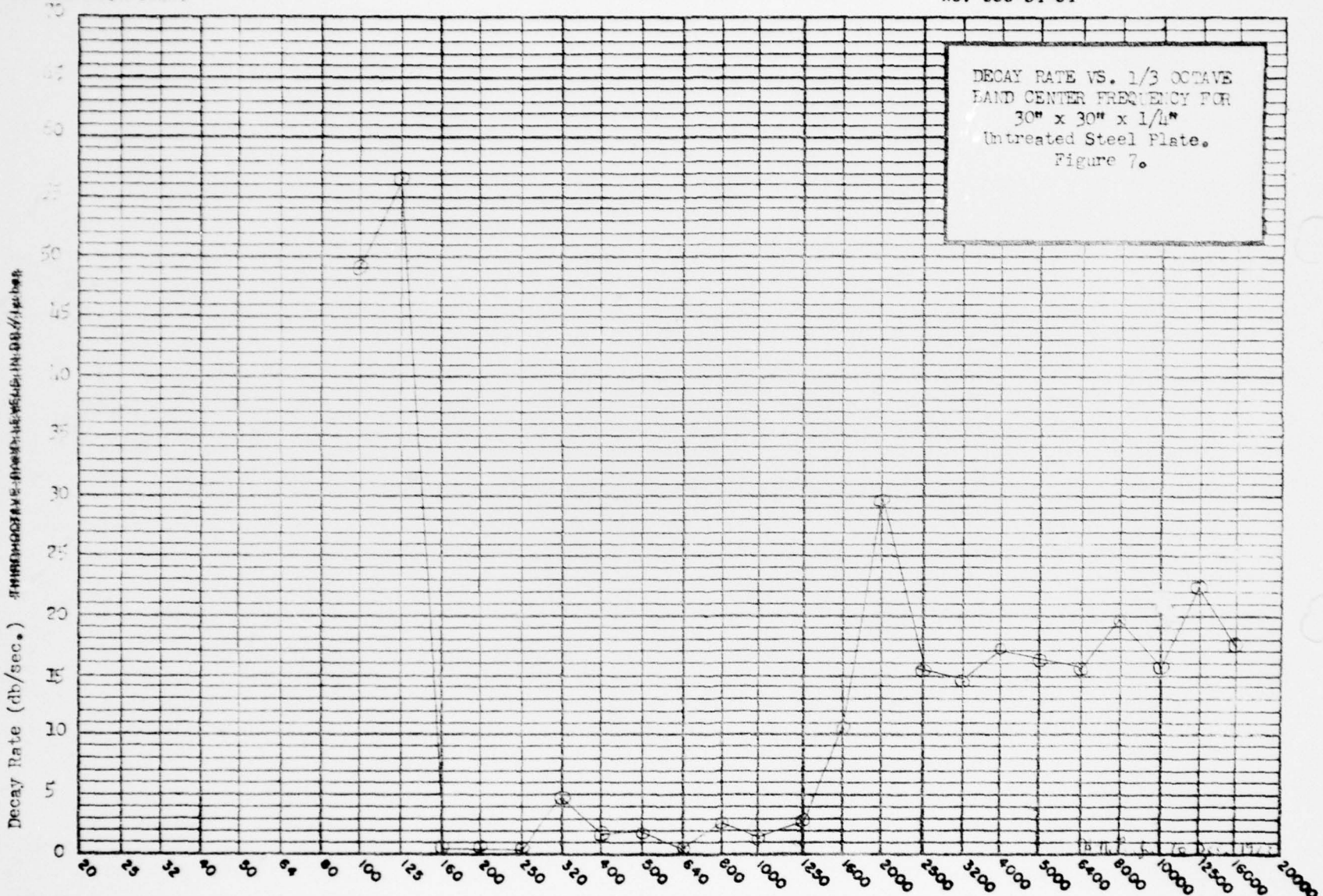

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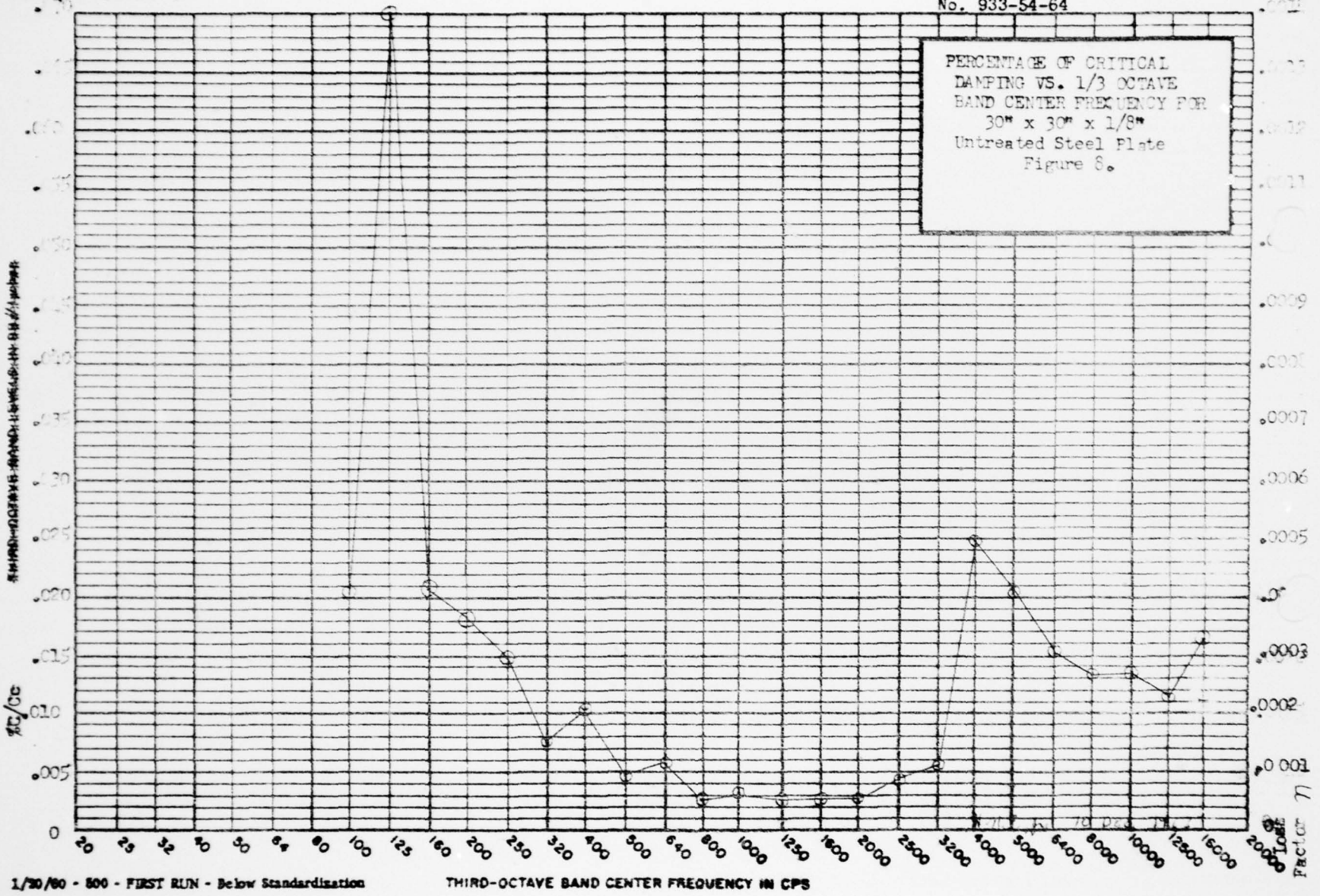

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THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

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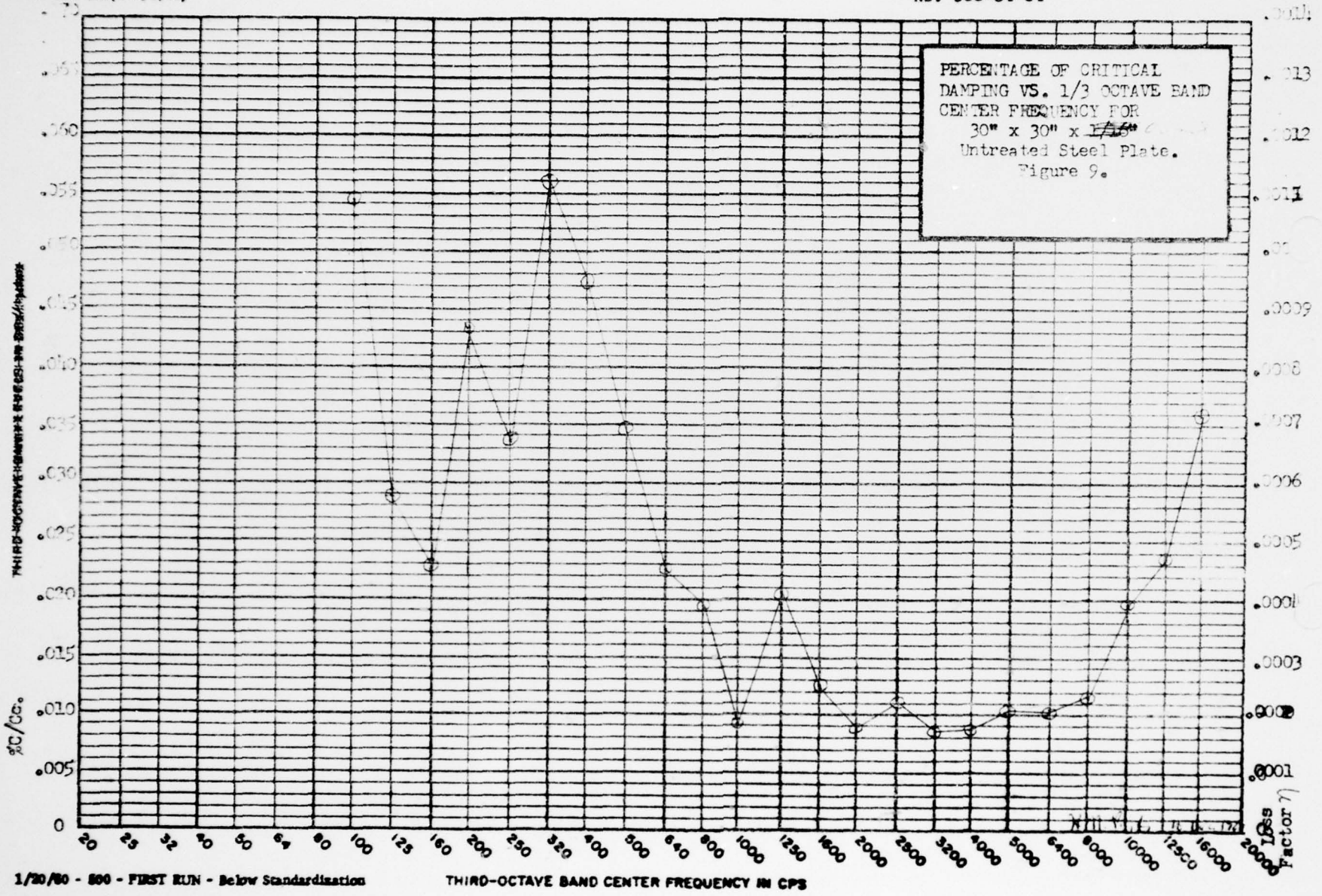

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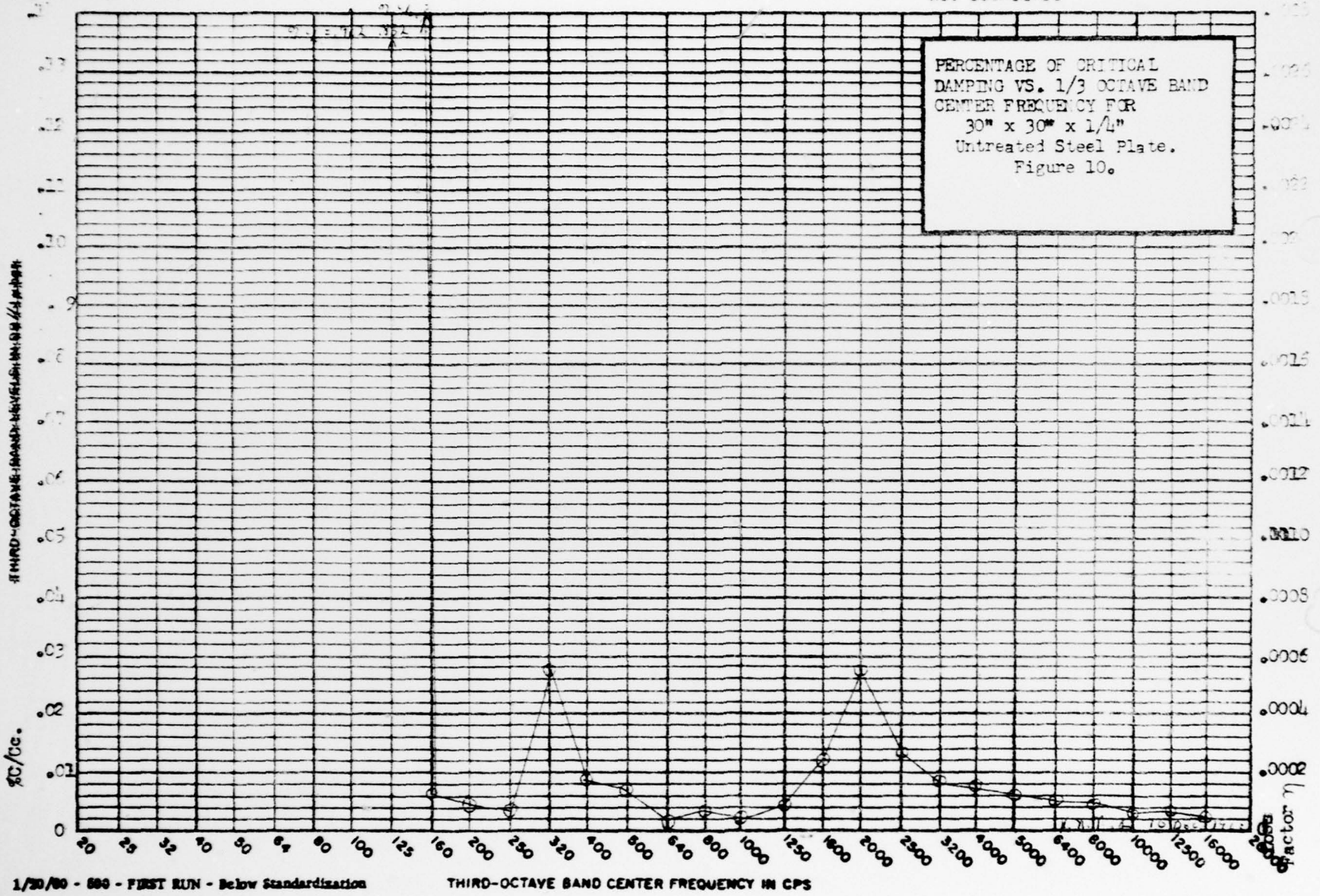

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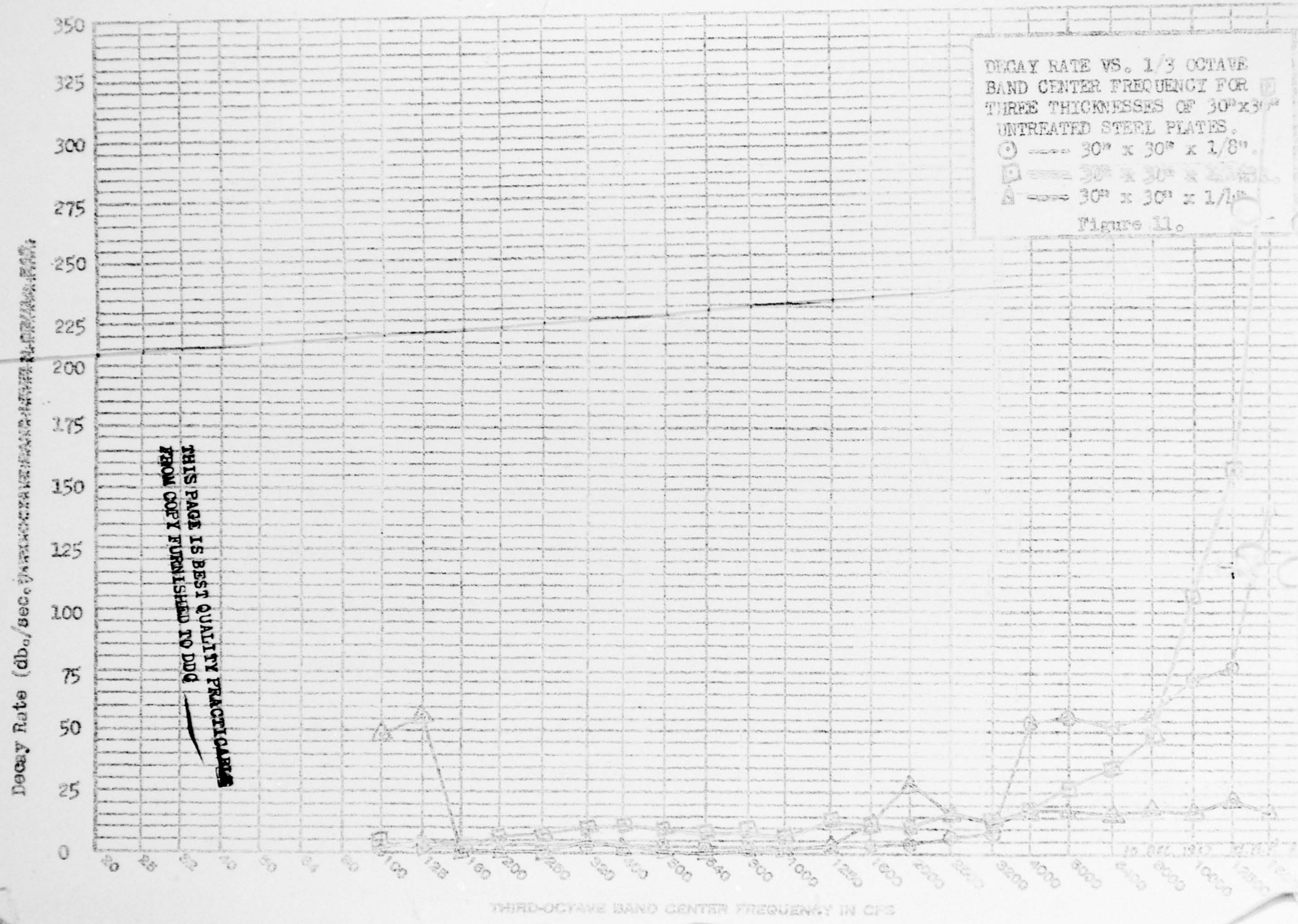

DECAY RATE VS. 1/3 OCTAVE BAND CENTER FREQUENCY FOR THREE THICKNESSES OF 30"x30" UNTREATED STEEL PLATES.

Figure 11.

$\eta_0/C_0 = 0.832$ @ 125 cps.
$\eta_0/C_0 = 0.902$ @ 100 cps.

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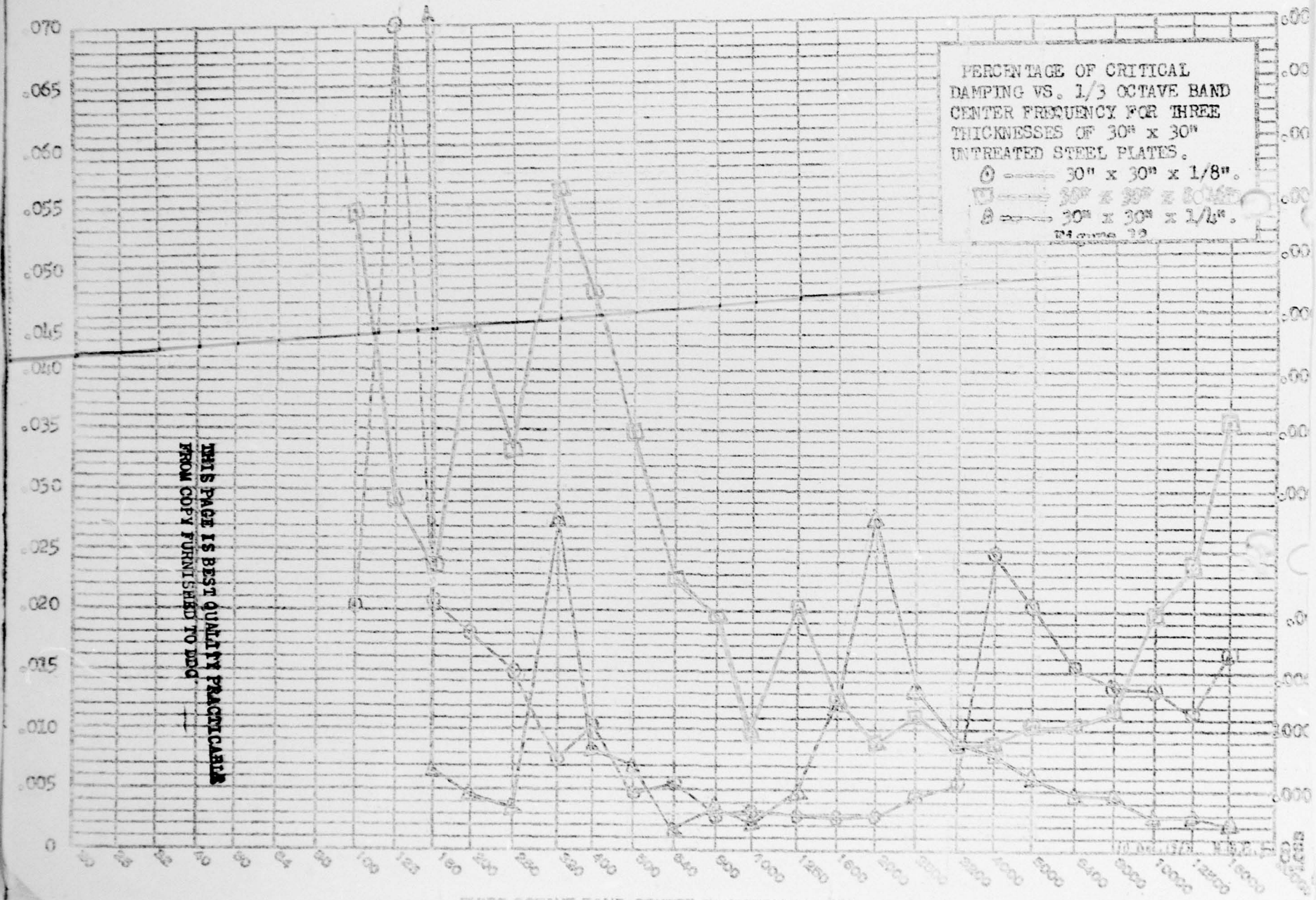

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